

Summary of the Activities and Qualifications

of

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EDUCATIONAL BACKGROUND

Ph.D. in Materials Science: Polymer Science

University of Connecticut, 1977. GPA 4.0/4.0. Earned support as a graduate assistant in the Chemical Engineering Department. Thesis subject—Effect of the Environment on the Toughness of High Impact Plastics. Major thesis advisor—Dr. A.T. DiBenedetto.

M.S. in Textile Chemistry

Lowell Technological Institute, 1968. GPA 3.6/4.0. Earned expenses as a laboratory assistant at the Wool Bureau in Chelmsford, Massachusetts. Thesis subject—Swelling and Dye Diffusion of Poly(ethylene terephthalate) Film in Alcohols. Thesis advisor—Professor R.J. Peirent.

B.S. in Textile Chemistry

Lowell Technological Institute, 1967. GPA 2.5/4.0. Dean's list—junior and senior years. Earned expenses as a laboratory technician at the Robinson Top and Yarn Dye Works in Lowell, Massachusetts.

EMPLOYMENT HISTORY

A. Academic Experience

Professor

Plastics Engineering Department, University of Massachusetts Lowell, September 1979 to present. Course taught include: Adhesives and Adhesion, Applied Statistics, Composite Materials, Design of Experiments, Heat Transfer, Mechanical Properties of Polymers, Physical Properties of Polymers,

Instructor

Continuing Education, University of Massachusetts Lowell, January 1980 to present. Duties include: night school, plastics seminars, and on-site industrial training programs.

Courses taught in night school include: Adhesives and Adhesion, Characterization of Polymers, Composite Materials, Independent Study, Injection Molding, Physical Properties of Polymers, Plastics Mold Design I, Plastics Processing Engineering Laboratory, Polymer Materials Science I (Commodity Thermoplastics), Polymer Materials Science II (Engineering Thermoplastics), Processing Technology I, and Processing Technology II.

Seminars include: Adhesives and Adhesion, Advanced Design with Plastics, Composite Materials, Fracture, Hydraulics, Optical Properties of Polymers, Polyurethanes, Reaction Injection Molding, Statistical Process Control and Testing of Plastics.

On-site industrial training programs include: Ford, Gillette, Lucent Technologies, MaCom and Velcro.

Visiting Professor

Ching Hwa University, Beijing, The Peoples Republic of China, June 1985. Invited as a guest of the Ministry of the Chemical Industry to present a short course dealing with "The Mechanical Properties of Polymers and Composites".

Peking Institute of Chemical Technology, Beijing, The People's Republic of China, June 1985. Invited as a guest of the Ministry of the Chemical Industry to present short courses dealing with "The Processing of Plastics and Composites" and "Urethanes".

Guest Lecturer

Dennison Manufacturing Company, Employee Education Program, Framingham, Massachusetts, September to December 1981. Hired to teach a class on Adhesives and Adhesion.

Assistant Professor

Textile Sciences Department, Southeastern Massachusetts University, North Dartmouth, Massachusetts, September 1977 to June 1979. Courses taught: Advanced Dyeing. Chemical Technology of Finishing, Elementary Dyeing, Industrial Chemical Analysis and Polymer Chemistry.

Teaching Assistant

Chemistry Department, University of Connecticut, September 1974 to December 1974. Course taught: Freshman Chemistry.

B. Work Experience

Materials Research Engineer

Composites Development Division, United States Army Research Laboratory, Watertown, Massachusetts, June 1979 to September, 1996. Worked on the problems of ductile-brittle transitions in polycarbonate and other polymers. Also did research in the ballistic and detonic testing of polymers. Investigated failure mechanisms in polymers produced by weathering. Worked on the development of methods to adhesively bond structures made from metal matrix composites. Conducted research in the area of chemical stress cracking of plastics. Served as principal investigator on a project to develop a composite containment system for turbine rotor failures. Served on an Investigation Review Panel of the 9MJ Compulsator at the University of Texas.

Visiting Materials Research Engineer

Materials Research Laboratory, Ascot Vale, Victoria, Australia, January to July 1983. Developed a method to determine the kinetics of crazing at low loads in flexure that was used to evaluate the effects of time, stress, and moisture in acrylic. Also studied the plasticity in polymeric materials at high rates of loading and the effects produced by weathering. This investigation was done as part of a joint international program that was partially sponsored by a grant from the United States Army through the University of Lowell Research Foundation.

Director of Research

The Heminway and Bartlett Manufacturing Company, Watertown, Connecticut, 1969 to 1974. Responsibilities included: design and development of new products for specified end use applications, innovation of new equipment and processing methods to increase production, the transformation of batch processes to continuous operations, troubleshooting production problems, and technical support for customer service.

PROFESSIONAL ACTIVITIES

A. Research and Publications

1. Refereed Papers in Journals and Conference Proceedings

“The True Cost of Snaps” Presented at the 63rd Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in Boston on May 1, 2005 (with N. Staller).

“The Effects Of Processing Variables On The Weld-Line Strength Of Plastics In Aggressive Environments: Part I—Materials And Solvent Selection”, SPE Technical Papers (ANTEC) 60(1), 531 (2002). Presented at the 60th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in San Francisco on May 6, 2002 (with M.D. Charbonneau).

‘Design, Material And Processing Effects On The Tensile Properties Of Filled Polypropylene’, SPE Technical Papers (ANTEC) 60(2), 1352 (2002). Presented at the 60th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in San Francisco on May 6, 2002 (with A.M. Kirkwood).

‘Ballistic Impact Resistance of Composites with Different Fabric Structures and Configurations’, SPE Technical Papers (ANTEC) 60(2), 2105 (2002). Presented at the 60th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in San Francisco on May 6, 2002 (with J. Song, M. Auerbach, N. Amin, M. Price and C. Roche).

‘Bonding Glass to Metal With Plastic for Stability Over Temperature’, Proc. SPIE Vol. 4444, p. 165-176, Optomechanical Design and Engineering 2001, Alson E. Hatheway; Ed., 11/2001 (with C. L. Willis).

"Structural Adhesives for Bonding Optics to Metals: A Study of Optomechanical Stability", Proc. SPIE Vol. 4444, p. 177-184, Optomechanical Design and Engineering 2001, Alson E. Hatheway; Ed., 11/2001 (with C. L. Willis).

‘Epoxy Adhesives: Effect of Plasma Treatment and Surface Roughness on Epoxy to Polyethylene Bond Strength’, SPE Technical Papers (ANTEC) 59, (2001). Presented at the 59th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in Dallas from May 6-10, 2001 (with E.F. Bardsley).

‘Ballistic Performance of Different Configurations of Thermoplastic Composites’. Presented at the 32nd International SAMPE Technical Conference held in Boston, MA on Nov.7, 2000 (with J.W. Song and N. Amin).

‘Ultrasonic Absorption in Rubber Filled Epoxies’, SPE Technical Papers (ANTEC) 46(3), (2000). Presented at the 58th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers held in Orlando May 9, 2000 (with K. Gabriel).

‘Modulus Properties of Triaxially Braided Carbon Fiber/Epoxy Spars’ SPE Technical Papers (ANTEC) 46(3), (2000). Presented at the 58th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers held in Orlando from May 10, 2000 (with J. M. Veilleux).

‘Ballistic Impact Resistance of Thermoplastic Composites’, SPE Technical Papers (ANTEC) 46(3), (2000). Presented at the 58th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers held in Orlando May 11, 2000 (with J. Song).

‘Effects of Magnesium Hydroxide on the Physical Properties of a Semirigid PVC used in Wire Coating’, SPE Technical Papers (ANTEC) 46(3), (2000). Presented at the 58th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers held in Orlando May 11, 2000 (with J. Torone).

‘Materials Substitution: A Case History’, SPE Technical Papers (ANTEC) 40(3), 3299-3301(1994). Presented at the 52nd Annual Technical Conference (ANTEC) of the Society of Plastics Engineers held in San Francisco from May 2-6, 1994.

‘Lightweight Aircraft Turbine Protection’. American Institute of Aeronautics and Astronautics paper number AAIA 93-1815. Presented at the AIAA/SAE/ASME/ASEE Joint Propulsion Conference and Exhibit held in Monterey, CA, June 28, 1993 (with J.J. DeLuca, B.C. Fenton, and J.T. Salvino).

‘The Effects of Polymer Viscoelasticity on Fiber Attrition when Compounding Fiberglass Strand on the Co-Rotating Intermeshing Twin Screw Extruder’, SPE Technical Papers (ANTEC) 39, 3380 (1993). Presented at the 51st Annual Technical Conference of the Society of Plastics Engineers that was held in New Orleans from May 3-7, 1993 (with J. Grillo).

‘The Investigation of the MK83 Bomb Ablative Coating Failure’, Proceedings of the 5th Fire Safety Conference and Exhibition held on February 15, 1993 in Orlando (with V. Champagne, P. Dehmer and G. Wechsler).

“An Assessment of the Adhesive Bondability of Silicon Carbide Reinforced Aluminum”, International SAMPE Conference Series 22, 815-24 (1990). Presented at the 22nd International Technical Conference held in Boston on November 6-8 1990 (with P.R. Bergquist and S.E. Wentworth).

“Evaluation of Lightweight Material Concepts for Aircraft Turbine Engine Turbine Protection”, International SAMPE Technical Series 22, 319-33 (1990). Presented at the 22nd International Technical Conference held in Boston on November 6-8 1990 (with J.J. DeLuca).

“The Effects of Ultraviolet Light and Pigments on the Physical Properties of Polycarbonate”, SPE Technical Papers (ANTEC) 36, 25-28 (1990). Presented at the 48th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in Dallas from May 7-11, 1990 (with G. Croteau).

“The Effect of the Heating Rate on the Shear Strength of a Room Temperature Cured Epoxy Resin”. Published in “How to Apply Advanced Composites Technology”, ASM International, 1988, pp. 181-187. Presented at the Fourth Annual Technical Conference on Advanced Composites held in Dearborn, Michigan on September 13-15, 1988 (with M. Mathews).

“The Effects of Water Immersion on the Shear Strength of Epoxy-Bonded Stainless Steel”. Published in “How to Apply Advanced Composites Technology”, ASM International, 1988, pp. 235-243. Presented at the Fourth Annual Technical Conference (ANTEC) on Advanced Composites held in Dearborn, Michigan on September 13-15, 1988 (with K.A. Geddes).

“The Effect of Processing Variables on the Structural Integrity of Filled Polypropylenes”, SPE Technical Papers (ANTEC) 33, 534-537 (1988). Presented at the 46th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in Atlanta from April 18-21, 1988 (with R. Quigley).

“The Effects of Processing Variables on the Environmental Stress Cracking of Rotation Molded Polypropylenes, SPE Technical Papers (ANTEC) 32, 472-474 (1987). Presented at the 45th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in Los Angeles from May 4-7, 1987 (with S.D. Kohlman and C.R. Desper).

“A Statistical Evaluation of Processing Parameters in the Counter Rotating Twin Screw Extruder: Effects of Mixing’. Published in the Proceedings of the third Annual Meeting of the Polymer Processing Society. Presented in Stuttgart, West Germany on April 8, 1987 (with S.F. Quigley).”

“Orientation Effects on the Heat Deflection Temperature of Filled Polypropylenes’, SPE Technical Papers (ANTEC) 32, 522-525 (1986). Presented at the 44th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in Boston from April 27-May 1, 1986 (with A. Kagle).

“The Effect of UV Degradation on the Behavior of Polycarbonate in High-Rate Impact’, SPE Technical Papers (ANTEC) 32, 602-605 (1987). Presented at the 44th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers that was held in Boston from April 27-May 1, 1986.

“Magnesium Hydroxide as a Flame and Smoke Suppressant for Polypropylene’, SPE Technical Papers (ANTEC) 32, 1167-1170 (1987).

Presented at the 44th Annual Technical Conference of the Society of Plastics Engineers that was held in Boston from April 27-May 1, 1986 (with L. Keating and G.F. Beekman).

“Injection Molding of a Transparent Polyurethane: A Statistical Evaluation’, Polymer Eng. And Sci., 25(1), 19-28(1985). (with J.J. DeLuca)

“Some Observations on the Craze Growth Kinetics of a Crosslinked Poly(methyl methacrylate)’, Journal of Materials Science, 20, 967-974(1985). (with P.J. Burchill and R.H. Stacewicz)

"The Recycling of Low Density Polyethylene Film", SPE Technical papers (ANTEC), 31, 96-99(1985). Presented at the 42nd Annual Technical Conference (ANTEC) of the Society of Plastics Engineers which was held in Washington, DC on April 29-May 2, 1985. (with J.H. Sayago) We were also invited to present this paper at the Technical Association of the Pulp and Paper Industry Conference which was held in Chicago in September, 1985.

"The Brittle Failure of Polycarbonate in High Rate Impact", SPE Technical Papers (ANTEC), 31, 630-633(1985). Presented at the 42nd Annual Technical Conference (ANTEC) of the Society of Plastics Engineers which was held in Washington, DC on April 29-May 2, 1985.

"The Effect of Processing Parameters on the Mechanical Properties of a Polyester Sheet Molding Compounding", SPE Technical Papers (ANTEC), 31, 1102-1106(1985). Presented at the 42nd Annual Technical Conference (ANTEC) of the Society of plastics Engineers which was held in Washington, DC on April 29-May 2, 1985. (with K.A. Malburne)

"Effects of Stress and Exposure on the Craze Growth Kinetics of a Crosslinked Acrylic", Presented at the symposium on "Failure Mechanisms in High Performance Materials" sponsored by the National Bureau of Standards which was held in Gathersburg, Maryland on May 2, 1984. (with P.J. Burchill and R.H. Stacewicz)

"A Statistical Evaluation of Coupling Agents for Mica Reinforced High Density Polyethylene", SPE Technical Papers (ANTEC), 30, 762-764(1984). Presented at the 41st Annual Technical Conference (ANTEC) of the Society of plastics Engineers that was held in New Orleans on May 1-5, 1984. (with R.J. Tremblay and S.F. Quigley)

"Effects of processing on the Mechanical Properties of Carbon Short-Fiber Reinforced Polycarbonate", Polymer Composites, 4(1), 47-52(1983). (with W.E. Haskell, III, and R.W. Lewis)

"Fracture Toughness of a Short-Fiber Reinforced Thermoplastics", Polymer Eng. and Science, 23(14), 771-775(1983). (with W.E. Haskell, III, and R.W. Lewis)

"The Effect of Liquid Coupling Agents on the Mechanical Properties of Mica-Reinforced High Density Polyethylene", SPE Technical Papers (ANTEC) 29, 323-325(1983). Presented at the 40th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers which was held in Chicago from May 2-6, 1983. (with R.J. Tremblay and S.F. Quigley)

"Effects of Processing on the Optical Properties of a Transparent Polyurethane", SPE Technical Papers (ANTEC) 29, 730-733(1983). Presented at the 40th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers which was held in Chicago from May 2-6, 1983. (with J.J. DeLuca)

"High Speed Thin-Walled Injection Molding of Poly-Para-Methyl-Styrene", SPE Technical Papers (ANTEC) 29, 720-733(1983). Presented at the 40th Annual Technical Conference (ANTEC) of the Society of Plastics Engineers which was held in Chicago from May 2-6, 1983. (with S. Avedekian)

"Fracture Toughness of a Short-Fiber Reinforced Thermoplastic" , NATEC Preprints, 187-90 (1982). Presented at the National Technical Conference of the Society of Plastics Engineers which was held in Bal Harbor, Florida on October 25-27, 1982. (with W.E. Haskell, III, and R.W. Lewis)

"Mechanics Problems in Composite Main Rotor Blade Design", Proceedings of the Army Symposium on Solid Mechanics 1982 - Critical Problems in System Design, AMMRC MS 82-4, September 1982. Presented at Bass River, Massachusetts. (with R.L. Foye, D.J. Baker, and A.O. King)

"Effects of Processing on the Mechanical Properties of Carbon Short-Fiber Reinforced Polycarbonate", The Society of the Plastics Industry, Reinforced Plastics/Composites Institute, 37th Annual Conference Preprint, 11F1(1982). Presented in Washington, DC on January 13, 1982. (With W.E. Haskell, III, and R.W. Lewis)

"The Effects of Stress Cracking on the Fracture Toughness of Polycarbonate", Polymer Eng. and Science 20, 385(1980). (with A.T. DiBenedetto and J. Miltz)

"Nucleation and Growth of Crazes in Polycarbonate Exposed to Ethanol", Journal of Materials Science 14, 246(1979). (with A.T. DiBenedetto and J. Miltz)

"The Environmental Stress Crazing of Polycarbonate", Journal of Materials Science 13, 1427 (1978) .(with A.T. DiBenedetto and J. Miltz)

"The Effect of the Environment on the Stress Crazing of Polycarbonate", Journal of Materials Science 13, 2037(1978). (with A.T. DiBenedetto and J. Miltz)

"Effects of the State of Stress on the Toughness of Polycarbonate", Polymer Eng. and Science 18, 1200(1978). (with A.T. DiBenedetto and J. Miltz)

"Amine-Cured Epoxy Resins: Adhesion Loss Due to Reaction with Air", J. Appl. Polym. Sci. 21, 1095(1977). (with J.A. Reffner and J.P. Bell)

"Crystallite Orientation in Heat Shrinkable Polytetrafluoroethylene Tubing", Journal of Materials Science, 2173(1976). (with J.R. Knox)

2. Other Major Publications

"Crazing and Fracture", Engineering Materials Handbook, Vol. 2, Engineering Plastics, ASM International, Metals Park, Ohio, 1988, pp. 734-740.

"Effect of the Environment on the Toughness of High Impact Plastics" Ph.D. Thesis, University of Connecticut, June 1978.

"Swelling and Dye Diffusion of Poly(ethylene terephthalate) in Alcohols" M.S. Thesis, Lowell Technological Institute, June 1968.

3. Articles in Trade Publications

"Evaluating Surface Treatments for Bonding Reinforced Metals", Adhesives Age, April 1991, pp 38-43 (with P.R. Bergquist and S.E. Wentworth).

"Magnesium Hydroxide: A Halogen-Free Flame-Retardant and Smoke Suppressant for Polypropylene", Plastics Compounding, July/August (1986). (With L. Keating and G. Beakmam.)

4. Research Reports

"Mechanical Properties of Mica-Reinforced Polypropylene" A report submitted to the Wet Ground Mica Association in Orleans, Massachusetts. This research was sponsored by a grant through the University of Lowell Research Foundation. The results of the project were cited in the October 1981 edition of "Plastics Engineering".

"Mica-Reinforced Thermoplastics" A report submitted to the Wet Ground Mica Association in Orleans, Massachusetts. This research was also sponsored by a grant and published as a trade brochure.

"The Effect of Liquid Coupling Agents on the Mechanical properties of Muscovite Mica-Reinforced High Density Polyethylene" A report submitted to the Wet Ground Mica Association in Orleans, Massachusetts. This research was supported by a grant and published as a trade brochure.

5. Invited Lectures and Presentations

"Environmental Durability of Adhesive Bonds to Silicon Carbide Particulate Reinforced Aluminum" Presented at the 6th International Symposium on Structural Adhesives Bonding held in Morristown, New Jersey on May 5-7, 1992. (With P.R. Bergquist and S. Wentworth)

"Composites with Applicability to Blast Resistant Containers" Presented at the FAA Explosive Effects Workshop held in Atlantic City on April 30, 1992 (with J. Mackiewicz).

"Turbine Blade Containment" Presented at the Third Annual Meeting of the US/France DEA #1396 which was held in Watertown, Massachusetts on July 16, 1991.

"Applications of Statistics and Statistically Designed Experiments to the Quality and Processing of plastics" Presented at the 48th Annual Technical Conference of the Society of Plastics Engineers which was held in Dallas from May 7-11, 1990.

"Ballistic Protection of Laser Hardened Materials"
Presented at the Eighth Annual Lasers on the Modern Battlefield Conference which was held at the Division of Occular Hazards, Letterman Army Institute of Research, Presidio of San Francisco, California on October 21, 1986. (With P.G. Dehmer) .

"Kinetics of Craze Growth in Acrylics" Presented at the ASTM -Aerospace Transparent Enclosures and Materials Meeting which was held in Seattle, Washington on October 17, 1985.

"Magnesium Hydroxide: A Non-Halogenated Flame and Smoke Suppressant for polypropylene" This paper was presented at the Joint Meeting of the Society of plastics Engineers and the Fire Retardant Chemical Manufacturers Association in Houston on March 25-27, 1985. (with L.F. Keating and G.F. Beekman)

"Solid Coupling Agent for Mica-Reinforced HDPE" Presented at the 136th Meeting of the Wet Ground Mica Association which was held in Boston, Massachusetts on November 3, 1982.

"Development of a Test Method to Evaluate the UV Degradation of Polycarbonate", Presented at the ASTM-Aerospace Transparent Enclosures and Materials Meeting which was held in Arlington, Texas on October 21, 1982.

"Liquid Coupling Agents for Mica-Reinforced HDPE" presented at the 135th Meeting of the Wet Ground Mica Association which was held in Orleans, Massachusetts on August 13, 1982.

"Effects of Artificial Weathering on the Mechanical Properties of Polycarbonate at High Rates of Impact" Presented at the Twenty-Eighth Meeting of the Technical Cooperation program Subgroup on Organic Materials that was held in Waltham Abbey, Essex, England, on June 17, 1982.

"Mica-Reinforced Thermoplastics" Presented at the 134th Meeting of the Wet Ground Mica Association that was held in Orleans, Massachusetts on October 2, 1981.

"The Mechanical Behavior of Polycarbonate at High Rates of Loading" Presented at the ASTM -Aerospace Transparent Enclosures and Materials Meeting that was held in Buena Park, California on October 23, 1981.

"A Mathematical Model for the Perforation of Polycarbonate at High Rates of Impact" Presented at the 27th Meeting of the Technical Cooperation Program Subgroup on Organic Materials that was held in Watertown, Massachusetts on June 12, 1981.

"The Mechanical Properties of Mica-Reinforced polypropylene"
Presented at the 133rd Meeting of the Wet Ground Mica
Association held in Tewksbury, Massachusetts on January 29, 1981.

"Ductile-Brittle Transitions in Polycarbonate at High Rates of Impact"
Presented at the 26th Meeting of the Technical Cooperation Program
Subgroup on Organic Materials that was held in Melbourne, Australia
from April 17-25, 1980. (Presented by Dr. R.W. Lewis).

"The Brittle Failure of Polycarbonate in Ballistic Impact" Presented at
the Army Materials and Mechanics Research Center in Watertown,
Massachusetts on November 16, 1979.

B. Membership in Professional Societies

Former member of the Society of Plastics Engineers (SPE). Served as
the faculty advisor for the student chapter at the University of Lowell
and as a member of the Board of Directors of the Eastern New England
Section.

Former Member of the American Institute of Aeronautics and
Astronautics (AIAA).

Former Member of the Society for the Advancement of Materials and
Process Engineering (SAMPE).

Former member of ASTM -previously served on the national
committee (F 7.08) for Aerospace Transparent Enclosures and Materials.

Former member of the Society for Experimental Stress Analysis
(SESA).

Former member of the Adhesion Society.

Former member of the Elastomers and Plastics Group of the New
England Region of the ACS -held office of Secretary.

Former member of the American Association of Textile Chemists and
Colorists (AATCC). Held offices of Chairman, Vice Chairman, and
Secretary in the Western New England Section.

Former member of the Waterbury Industrial Management Club (IMC) - held offices of President and Secretary.

C. Other Studies and Interests

Completed a Chautauqua-Type Short Course in the REFOCUSING CALCULUS AT A WIDE RANGE OF INSTITUTIONS held at Harvard University from April 13-15, 1993.

Completed a 15-week course in PENETRATION MECHANICS given at the United States Army Materials Technology Laboratories in Watertown, Massachusetts in 1986.

Completed a Chautauqua-Type Short Course in the PHYSICS AND CHEMISTRY OF MODERN MATERIALS held at the University of Pennsylvania from April 24-27, 1985.

Completed a one day short course in BLOW MOLDING given by the Society of Plastics Engineers in the Polymer Program at Drexel University on May 18, 1984.

Completed 40 hours of training in OPTICAL METHODS IN STRESS ANALYSIS CONTOURING AND NON-DESTRUCTIVE TESTING which was given by the Society for Experimental Stress Analysis at the U.S. Army Materials and Mechanics Research Center in Watertown, Massachusetts during June of 1982.

Completed a course in COMPOSITES which was jointly given by the Society of Plastics Engineers and the Society for Experimental Stress Analysis in Chicago, Illinois in September 1981.

Completed a course in OPTICAL MICROSCOPY, which was given by the McCrone Research Institute in Chicago, Illinois in June, 1979.